Single-Incision Laparoscopic Cholecystectomy Using Conventional Laparoscopic Instruments and Comparison with Three-Port Cholecystectomy

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Abstract Single-incision laparoscopic surgery also known as laparo-endoscopic single-site surgery for cholecystectomy is performed using a single umbilical skin incision through which a laparoscope and two instruments are introduced. It is virtually a “scarless” surgery. The present study was undertaken to evaluate the efficacy of single-incision laparoscopic cholecystectomy using conventional instruments and compare it with three-port laparoscopic cholecystectomy. Thirty patients who underwent single-incision cholecystectomy were compared to an equal number of patients who underwent three-port cholecystectomy. Both groups were assessed on the basis of operative time, intraoperative complications, postoperative pain, ambulation, hospital stay, and body image at first and third week. Single-incision cholecystectomy had the advantage of less postoperative pain, early ambulation, and better body image as compared to three-port cholecystectomy; the results being statistically significant. There was no statistically significant difference in operative time and hospital stay between the two groups. Single-incision laparoscopic cholecystectomy using conventional instruments is a safe and effective

surgery. It gives better cosmetic results, almost scarless surgery, without increasing the cost of surgery.

Keywords Single-incision laparoscopic cholecystectomy · Three-port laparoscopic cholecystectomy · Laparo-endoscopic surgery · Laparo-endoscopic single-site surgery

Introduction

Laparoscopic cholecystectomy is the procedure of choice in gallbladder diseases. Reducing the number of ports in the procedure does not affect the safety of procedure but further enhances the advantages of laparoscopy over open cholecystectomy [1]. A number of studies have described the advantages of three-port surgery and have challenged the value of fourth trocar [2]. Further reducing the number of ports to two did not affect the overall outcome of the procedure. In fact, three- and two-port laparoscopic cholecystectomies are less expensive, less painful, and less scar forming than four-port laparoscopic cholecystectomy [3].

First clinical use of a single opening approach to laparoscopic surgery was reported in human subjects as early as 1969 by Wheeler who successfully performed single puncture tubal ligation with a laparoscope [4]. This minimally invasive technique has also been named laparo-endoscopic single-site surgery. First transumbilical cholecystectomy was reported in 1997 by Navarra [5]. In early 1999, it was Piskun who used two 5-mm ports and two intra-abdominal stay sutures for the procedure [6]. The specimen was removed by joining the two 5-mm fasciotomies. Cuesta and colleagues fixed the fundus of the gallbladder using a 1-mm Kirschner wire introduced at the subcostal line [7]. Cholecystectomy has

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Table 1 Showing mean intraoperative time in two groups

Group	Number	Mean time (min)	SD	<i>t</i> value	<i>p</i> value
Single incision	30	34.20	9.86	0.067	0.947 NS
Three port	30	34.37	9.32		

NS not significant ($p > 0.05$)

been one of the most commonly performed natural orifice transluminal endoscopic surgery (NOTES) procedures to date, with the majority being performed through the transvaginal approach [8]. Transumbilical endoscopic surgery is feasible and would be another option for scarless abdominal surgery. Single-port transumbilical laparoscopy, also known as embryonic natural orifice transumbilical endoscopic surgery, has emerged as an attempt to further enhance cosmetic benefits and reduce morbidity of minimally invasive surgery [9].

Single-incision laparoscopic surgery for cholecystectomy is performed using a single umbilical skin incision through which a laparoscope and two instruments are introduced and cholecystectomy is performed. It is virtually “scarless” surgery with entry point hidden in the umbilicus. The fundamental idea is to allow all of the laparoscopic instruments to enter through one skin incision.

The present study was intended to evaluate the efficacy of the single-incision laparoscopic cholecystectomy using standard laparoscopic instruments. This study was undertaken to compare the overall benefits of single-incision laparoscopic cholecystectomy with three-port laparoscopic cholecystectomy using standard laparoscopic instruments.

Methods and Materials

The study was carried out in 60 patients suffering from gallbladder diseases in a medical college hospital over a

period of 1 year from 1 November 2010 to 31 October 2011. Informed consent was obtained from the patients and approval was obtained from the designated review board of the institution involved. The patients were randomly allocated to two groups comprising 30 patients each. One group was subjected to single-incision cholecystectomy and the other to three-port cholecystectomy. Both groups were assessed on the basis of operative time, intraoperative complications, postoperative pain, ambulation, hospital stay, and body image at first and third week.

Patients were enrolled in the study after fulfilling the eligibility criteria. The criteria for inclusion included elective surgery for gallstone disease and gallbladder polyp with normal common bile duct (on preoperative ultrasound). And the criteria for exclusion included obesity ($\text{BMI} > 34 \text{ kg/m}^2$), acute cholecystitis, choledocholithiasis, previous upper abdominal surgery, umbilical hernia, or any uncontrolled medical disease like hypertension, coronary artery disease, diabetes mellitus, COPD, asthma, etc.

Three-Port Cholecystectomy

Three-port cholecystectomy was performed using three ports, i.e., two 10-mm and one 5-mm port in the umbilical, epigastrium, and right hypochondrium, respectively. Pneumoperitoneum was generated using CO_2 insufflation with the help of Veress needle, through the umbilical port. The rest of the procedure was similar to conventional laparoscopic cholecystectomy.

Fig. 1 Distribution of patients according to intraoperative time

Table 2 Comparison of intraoperative parameters

Serial Number	Parameters	Single-incision group	Three-port group	<i>p</i> value
1	Duration (mean)	34.20	34.37	>0.05
2	Fundal suture			>0.05
	Yes	1	0	
	No	29	30	
3	Additional mini-epigastric port			>0.05
	Yes	4	3	
	No	26	27	
4	Conversion to standard lap	0	0	–
	cholecystectomy			
5	Port site bleeding	0	0	–
6	CBD injury	0	0	–
7	Excessive hemorrhage	0	0	–

Single-Incision Laparoscopic Cholecystectomy with Conventional Instruments

Single-incision laparoscopic cholecystectomy was done by making a single infraumbilical incision about 2.5 cm. Pneumoperitoneum was created by using a Veress needle. A 10-mm port was placed, through which a 30° laparoscope was introduced, one 5-mm and another 10-mm port was introduced on either side of the central port through the same incision but through separate fascial defects (Photograph 1 of the Electronic Supplementary Material). A 5-mm grasper was introduced through the right port for traction of fundus, and the 10-mm left port was used as working instrument. The working instrument in the left lateral port was placed in 2 o'clock position and the other instrument was placed in the right lateral in 10 o'clock position for gallbladder retraction leading to triangulation of instruments. Posterior dissection was done and gallbladder was lifted. This helped in easy identification and dissection of Calot's triangle. Clip applicator was introduced through the left lateral 10-mm port. After dissection of gallbladder from the bed and achieving hemostasis, the gallbladder was removed through the 10-mm left lateral port.

Statistical Analysis

Data were entered into a Microsoft Excel spreadsheet and translated into native Statistical Package for Social Sciences

Table 3 Descriptive statistics of patients for pain according to VAS score

Group	Number	Mean	SD	<i>t</i> value	<i>p</i> value
Single incision	30	5.23	0.69	2.936	0.005*
Three port	30	5.73	0.63		

**p*<0.05, significant

format. A maximum *p* value of 0.05 was considered statistically significant.

Results

The minimum and maximum time taken for single-incision cholecystectomy from port insertion to port removal were 16 and 55 min and in case of three-port cholecystectomy were 18 and 60 min, respectively (Table 1 and Fig. 1). The difference of time duration between the two groups was not statistically significant.

Fundal suture was used in one of the patients in single-incision cholecystectomy to retract the fundus and better visualization of Calot's triangle. However, no such suture was used in three-port cholecystectomy. Additional mini-epigastric port was used intraoperatively in four patients in case of single-incision cholecystectomy and two patients in case of three-port cholecystectomy due to extensive adhesions around the gall bladder. The difference between the two groups is being statistically insignificant.

Mean duration of surgery in both groups is nearly the same. The intraoperative parameters observed between both the groups showed no statistical significance as described in Table 2.

There was a statistically significant difference in the postoperative pain scores using visual analogue scoring. The pain score in single-incision group was less as compared to other group (Table 3).

Table 4 Descriptive statistics of patients according to mean time taken to start ambulation (in hours) in two groups

Group	Number	Mean	SD	<i>t</i> value	<i>p</i> value
Single incision	30	5.60	0.62	3.780	<0.001 ^a
Three port	30	6.27	0.74		

^a Highly significant

Fig. 2 Time taken to start ambulation (in hours) in two groups

Most of the patients in single-incision group were ambulated within 5–6 h after the procedure; the results being statistically significant when compared to the other group (p value < 0.001; Table 4 and Fig 2). All patients except two in the single-incision group and one in three-port group were discharged on first postoperative day. These three patients were discharged on second postoperative day because they lived in far-flung areas.

All the patients in the single-incision group were highly satisfied and happy with the cosmetic appearance of the incision (Photographs 2, 3, 4, and 5 of the Electronic Supplementary Material). The difference between the two groups was statistically highly significant (Tables 5 and 6).

Discussion

The fear of operation, disfiguring scars, prolonged recovery, and associated pain are the major concerns of most of the patients undergoing cholecystectomy.

The conventional laparoscopic cholecystectomy is generally performed through four small incisions in the abdomen: one for optic source and other three for surgical instruments [10]. In recent years, a less invasive method

has been sought in an effort to reduce postoperative pain and morbidities such as wound infection and trocar site hernias while further enhancing the cosmetic results. There have been attempts to perform the procedure through three and then two ports or with reduced diameters of the trocars as done by Tagaya et al., Leung et al., and Ngoi et al. [11–13]. Further decreasing the number of ports, single-incision laparoscopic surgery has come in practice as suggested by Pelosi et al. [14]. Single-incision laparoscopic surgery refines the use of laparoscopic surgery, allowing procedures to be carried out through a single incision, making the procedure even more minimally invasive.

The chopstick effect of instruments due to limited space observed by many authors in their series of single-incision laparoscopic cholecystectomy (SILC) was overcome by positioning the working instrument at 2 o'clock position and other instrument at 10 o'clock position used to retract the fundus of gallbladder, which helps in better visualization of Calot's triangle and facilitates the dissection [15, 16]. This leads to triangulation of instruments and dissection was made easy. No sword fighting was observed. This was in discordance with most of the studies which suggested crossing over of instruments to increase the working space [17].

Table 5 Distribution of patients according to body image of patients on first week of follow-up

Body image on first week	Single-incision group	Three-port group	Total
1–3 (poor)	0	0	0
4–7 (good)	8	30	38
8–10 (excellent)	22	0	22
Total	30	30	60

$p < 0.001$, highly significant

Table 6 Distribution of patients according to body image of patients on third week of follow-up

Body image third week	Single-incision group	Three port group	Total
1–3 (poor)	0	0	0
4–7 (good)	0	11	11
8–10 (excellent)	30	19	49
Total	30	30	60

$p < 0.001$, highly significant

In one of the cases, there was very long fundus falling over the Calot's area. In this case, we used a fundal suture, i.e., we used a straight needle with 0-silk passing stitch in the last right intercostal space through the fundus. The stitch was secured with a knot by using a single needle holder to retract the fundus area and fundus was moved towards cephalad position and the procedure was carried out safely. This technique is frequently used to hold organs in NOTES and in single-incision cholecystectomy and was not considered an additional port [18, 19].

In four cases of single-incision cholecystectomy, we used a 5-mm mini-epigastric port to hold the fundus area for retraction because of massive omental adhesions due to which Calot's visualization was difficult. This use of mini-epigastric port in these cases made dissection easy. This 5-mm port mini-epigastric port has also been used by Rao et al. in their study.

The duration of the operative time ranged from 16 to 55 min, with the mean being 34.20 min as compared to mean duration of 34.37 min in case of three-port cholecystectomies. All the patients were given intraoperative dose of analgesic and next dose was scheduled 12 h later. The pain scoring was done 8 h after the surgery using a visual analogue score. Although not much difference was observed in the requirement of analgesia in comparison to three-port cholecystectomy, we observed a significant difference in the VAS score ($p < 0.05$). Prasad et al. in their study have also observed that pain scores in the single-incision group are less as compared to conventional laparoscopy group [20].

Most of the patients were ambulated within 6 h of the surgery and almost all of the patients were discharged on the first postoperative day. Two patients were discharged on second postoperative day on their own choice. Mean hospital stay was 1.07 ± 0.25 days and was comparable with the duration of hospital stay of patients of three-port cholecystectomy where mean hospital stay was 1.03 ± 0.18 days.

Body image comparison at first and third weeks between the two groups revealed statistically significant results. Almost all the patients of single-incision cholecystectomy were happy with the cosmetic appearance of the scar. This was in accordance to observations made by Noam et al. in his series of SILC on 31 patients. There was barely any visible scar and most of the patient's reported early return to daily activities within 7–10 days which indicated faster recovery.

Conclusion

Single-incision laparoscopic cholecystectomy using three ports through a single incision but entering through three different fascial defects using conventional instruments is a safe and effective surgery with better cosmetic results without increasing the cost of surgery. In difficult cases, the use of fundal suture or mini-epigastric port is recommended.

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